rents are induced in the iron, the energy-function of the magnetic circuit follows the more general law: —

$$H = \eta B^{1.6} + \varepsilon N B^2,$$

where H gives the loss of energy per cycle and cm^3, in absolute units, N is the frequency, or number of cycles per second, η the co-efficient of molecular friction or hysteresis, and ε a co-efficient of eddy currents.

Herefrom the loss of power per cm^3 of iron, in Watts, is derived, as

$$W = NH \times 10^{-7} = \left(\eta N B^{1.6} + \varepsilon N^2 B^2\right) \times 10^{-7}$$

The next problem was now, to determine the energy-function of the magnetic circuit for cyclic variations of magnetism between any two limits, B_1 and B_2, and to derive numerical values of the co-efficient of molecular friction, η, for different magnetic materials.

In the meantime, it had been found by Kennelly (Transactions of American Institute of Electrical Engineers, October, 1891) that Fröhlich's formula of magnetic induction —

$$B = \frac{H}{a + bH}$$

(where H is the magnetomotive force or field-intensity, a and b constants), which had been abandoned already as inexact, holds rigidly by a slight modification. Using not the whole magnetic induction, B, but the "metallic-magnetic induction," $L = B - H$, where H is the field-intensity, we find, that for infinitely large field-intensities H, the metallic induction L approaches a finite limiting value L_∞, and follows Fröhlich's formula: —

$$L = \frac{H}{a + \sigma H},$$

or, if we assume Ohm's Law for the magnetic circuit,

$$L = \frac{H}{\rho},$$

where ρ is the magnetic resistance, or reluctance, it is

$$\rho = a + \sigma H;$$

that is, the magnetic resistance is a linear function of the field-intensity.

On the hand of a large number of experimental determinations, made by the electro dynamometer and by the magnetometer method, comprising several thousands of readings, I was enabled to communicate to the American Institute of Electrical Engineers at the meeting of September, 1892, the results: —

1. The loss of energy by molecular-magnetic friction, per cycle and cm^3, for a cyclic variation of the magnetic induction between the limiting values L_1 and L_2, is expressed by the function —

$$H = \eta \left(\frac{L_1 - L_2}{2}\right)^{1.6}$$

where L_1 and L_2 most likely have to represent the metallic induction $L = B - H$.

When Foucault — or eddy — currents are present in the iron, the energy-function of the magnetic circuit takes the more general form —

$$H = \eta \left(\frac{L_1 - L_2}{2}\right)^{1.6} + \varepsilon N \left(\frac{B_1 - B_2}{2}\right)^2$$

where the first term gives the energy converted into heat per cycle and cm^3 by true molecular friction, the last term the energy converted into heat by Foucault currents.

2. Beyond a minimum value of field-intensity, Hm, the metallic magnetic resistance follows the linear law: —

$$\rho = a + \sigma H.$$

3. Beyond this minimum value of field-intensity, Hm, all the essential properties of magnetic materials can be expressed by three constants: —

a, the co-efficient of magnetic hardness;
σ, " " " " saturation;
η, " " " " hysteresis;

or, instead of this, by the three constants: —

$L_\infty = \frac{1}{\sigma}$, the value of absolute (metallic) magnetic saturation.

$H_0 = \frac{a}{\sigma}$, the critical field-intensity, or that field intensity where half-saturation, $\frac{L_\infty}{2}$, would be reached, if the linear law of magnetic resistance held already for this field-intensity H_0, and

$H_\infty = \eta L_\infty^{1.6}$, the maximum value of hysteretic loss, by means of the formulas: —

The equations of magnetic resistance, or reluctance —

$$\rho = a + \sigma H = \frac{H_0 + H}{L_\infty}$$

(corresponding to Ohm's Law in the electric circuit), and the energy-function —

$$H = \eta \left(\frac{L_1 - L_2}{2}\right)^{1.6} = H_\infty \left(\frac{L_1 - L_2}{2 L_\infty}\right)^{1.6}$$

(corresponding to the energy-function of the electric circuit, $W = c^2 R$).

4. These equations hold for all kinds of iron and steel, for nickel, cobalt, and magnetite, and most likely for the amalgams of iron, that is, for all magnetic materials.

5. In first approximation, the magnetic induction, B, and the magnetic hysteresis, or molecular friction, H, depend upon the magnetic field-intensity, H, by the law of probability of molecular distances.

6. Average values of magnetic constants are: —

For wrought-iron, soft cast-steel, and mitis metal —

$a = .38 \times 10^{-3}$ $\sigma = .055 \times 10^{-3}$ $\eta = .003$ $(Hm = 9)$;

for cast-iron and low-permeability cast-steel —

$a = 3 \times 10^{-3}$ $\sigma = .095 \times 10^{-3}$ $\eta = .013$ $(Hm = 22)$;

for soft welded-steel and medium-hard cast-steel of high permeability —

$a = 1.7 \times 10^{-3}$ $\sigma = .06 \times 10^{-3}$ $\eta = .02$ $(Hm = 50)$;

for glass-hard steel —

$a = 10 \times 10^{-3}$ $\sigma = .1 \times 10^{-3}$ $\eta = .07$ $(Hm = 110)$.

October, 1892.

THE APPARENT GROWTH OF GOLD.

BY RICHARD EAMES, JR., M.E.

OF the many myths prevalent regarding gold, the greatest one of all is its growth. Of course there are many interesting instances where ancient worked-out galleries in mines are slowly closing up by the incrustation process, so that space long ago excavated is being filled with an accumulation resulting from the percolation of water through the adjacent wall-rock. This water has in chemical combination such minerals as iron, copper, sulphur, and the precious metals, which are deposited in the open crevice, making for a second time a mineralized body which will show by analysis the above named and many more minerals. In fact, I have had this actual experience resultant on the examination of an old gold mine in Honduras, Central America, that had been worked some time prior to any history we have of that country. This circumstance gave to the natives the idea that gold grew, and they so expressed themselves; while it seemed in the case of one individual a transmutation idea had permeated his head, for he explained that the green carbonate of copper was undergoing a change into silver, while the silver in turn would develop into gold.

In India I found a caste of mining people who believed that gold grew in the bottom of the large lakes situated in that country. They expressed no practical reason other than fairy-tale superstitions. And even in this country there are converts to the idea. I was much amused and interested some years ago to hear an intelligent acquaintance maintain in strong and not altogether religious terms that "the stuff grew and he knew it." His experience was based on the fact that in a certain pile of tailings, resulting from the milling of heavy sulphuretted gold-ores, he had treated at one time several tons with no result. Again, in

three years time he discovered by a pan-test that the same pile had gold in it, whereupon he treated several tons with the approximate result of one dollar per ton. After this last treatment he declared the tailings were barren of gold so far as he could detect by the mechanical means at hand. In order to convince him I selected an average sample, which on assay gave 2 pennyweights, 20 grains gold per 2,000-pound ton. This was considered not worth the working. But my friend maintained that the gold would grow again in two or three years.

True to his word, in two years he was at the pile again, and by his crude but sure method was saving one dollar per ton from the ore that would yield *nil* by his methods two years before. Again, I took samples for assay and was somewhat surprised to find the value had increased just 50 per cent, as the result of my determination was 5 pennyweights, 16 grains per ton. On investigation, I found the sulphurets to be of a character readily decomposed by the elements; in fact to such an extent that, as I afterwards calculated, over one-half of the pile must have been decomposed or washed away, so that with the decomposition a certain rapid concentration was maintained by the action of heavy rains, and the natural advantage this particular ground offered causing the gold to remain behind while the oxides were carried away in suspension by the water. My explanation has failed to convince my friend of the pick and shovel. As the gold in the tailings has become about exhausted, his last attempt to make pay was a failure. He remains strong in the conviction that a few years will grow it again.

Gold Hill, North Carolina, October, 1892.

CURRENT NOTES ON ANTHROPOLOGY.—XVIII.

[*Edited by D. G. Brinton, M.D., LL.D.*]

The Early Age of Metals in Europe.

As has been previously remarked in these Notes, there is a growing tendency in European archæology to rate the civilization of Europe at the dawn of the historic period decidedly higher than has been heretofore supposed, and to regard it more and more of indigenous development. Those old theories which attributed pretty much all that deserved the name of culture to Asiatic or Egyptian sources are diminishing in favor.

An instance of this is seen in an article by M. Salomon Reinach in *L'Anthropologie*, 1892, No. 3, in which he discusses with his accustomed wealth of erudition the derivation of the name "Cassiterides," and with it the origin of tin and bronze in western Europe. He claims that this name is of Celtic origin, and means "Remote," or something of that kind. It was applied by the Gauls to the portion of western England whence came the tin. This conclusion proves several points, if once accepted. As Homer talks of the Cassiterides, it shows that before his time the tribes of western France spoke Celtic; that they worked in and exported metals; and it gives room to inquire whether one of the centres of the discovery of bronze was not in western Europe.

Other archæologists of ability, such as Franz von Pulszky, in the *Archiv für Anthropologie*, Bd., XX., have called attention to the fact that the specific civilization of the Celts was higher than is generally recognized. Their heavy iron swords, for striking, not thrusting, their ornamentation, derived from the circle and the triangle, and their use of torques, wound metal neck-rings, reveal positive ethnic art-capacity. Their presence in Hungary is well marked by such remains in the tombs of an early epoch.

Figurines of the Stone Age.

The glyptic art goes back far into the stone age, far even into the old or rough stone age. In the *Antiqua* for 1887–1890, R. Ferrer has discussed and depicted the earliest human statuettes from the European bronze and stone ages. The oldest always represent the individual naked, and the parts of sex very prominent. This is also the case with the Phœnician bronze figurines from Ellora, in Portugal, while those from the north are clothed.

Last December there were found some interesting remains near Brunn, Germany, at a depth of four and a half meters, amid bones of the mammoth, rhinoceros, and reindeer. They were a human skull, and adjacent to it a human figurine 20 centimeters high, carved from the tooth of a mammoth, and bored through, evidently for the purpose of suspension. The figure is naked and prominently masculine, though the mammæ are clearly represented.

The skull presented an index of 65.68, and was therefore singularly dolichocephalic; its estimated cubical capacity was 1,350 cubic centimeters; it was not prognathic, but the frontal sinuses were very prominent, and the glabella also, thus presenting an inferior character.

When the head of the figurine is regarded in profile, it presents this peculiar appearance of prominence in the glabellar region, thus showing that it was carved to imitate the then prevailing type of humanity.

These and other interesting facts about this noteworthy find are given in the Proceedings of the Niederrheinische Gesellschaft, 1892, by Professor Schaaffhausen of Bonn, who adds an engraving of the skull. Like all his articles, this one is prepared with the most satisfactory care.

The Study of Hair.

The study of the hair on man offers a most extensive field of inquiry, and one which presents many unsolved problems of the first order of importance. Some of these are discussed by F. Lapille in *Le Naturaliste* and by Dr. Bartels in the *Zeitschrift für Ethnologie* of recent dates.

Why man as a species should present the amount and kind of hair that he does is variously explained, and the differences between the varieties of the human race are so great in this respect that, as is well known, one of the most popular subdivisions of the species is founded upon it. Most mammals have more hair than man, but some less, as the Cetaceæ and the Sirenidæ. The anthropoid apes have, as a rule, much hair where man has little, as in the arm-pits and around the sex-organs. In some localities, as the ears and nose, the hairs are clearly protective organs, while around the genitals they appear to be merely ornamental. In monkeys, the females are bearded, but such examples are rare in the human species. Bearded women, however, are not otherwise masculine, but have the sentiments and the capacity for motherhood. Bartels describes a very hairy Gypsy girl, only seventeen years old, but already the mother of three children. With her the hairiness was from a naevus pigmentosus of extraordinary extent; and why these naevi should develop hairs is worth inquiry. Man has the longest hair of any animal, and why he lost it over most of his body is the subject of much curious speculation. The loss led him to the inventions of painting and tattooing his body, of covering it with clay or clothes, to depilation, to the sense of modesty, and to many other unexpected results. The history of hair in man is thus an extraordinary one for the evolution of the species.

On Quarry-Rejects.

For two or three years past there has been in the air — I mean the air which archæologists breathe — a low but menacing sound, threatening some dear theories and tall structures, built, if not on sand, at least on gravels offering a scarcely more secure foundation.

These menaces bear more directly on what is classically known as the "old stone age," that of chipped implements, and particularly on that period of it which is alleged to be characterized by very rude — and which are therefore supposed to be very old — types. The new views come from a study of the aboriginal quarries, the sites where the ancient tribes collected the materials which later and at other localities they worked up into finely chipped or polished implements. This part of the work they did not perform at the quarry; and pieces which after a few test-blows by their skilled hands they saw could not be utilized at all, or only at the cost of considerable labor, they threw aside and left on the spot. These are "quarry-rejects," and after you have handled and studied several hundreds of them you can always see why they were thrown away; you can recognize, as did the aboriginal artist, why they would prove worthless or troublesome in further working.